

# C Programming Tools: Part 1

## Building and Using your own Toolkit

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23rd May 2019

The handout and tarballs are available on CATE and at:

<http://www.doc.ic.ac.uk/~dcw/c-tools-2019/lecture1/>

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  - Learn how to write **portable code**.

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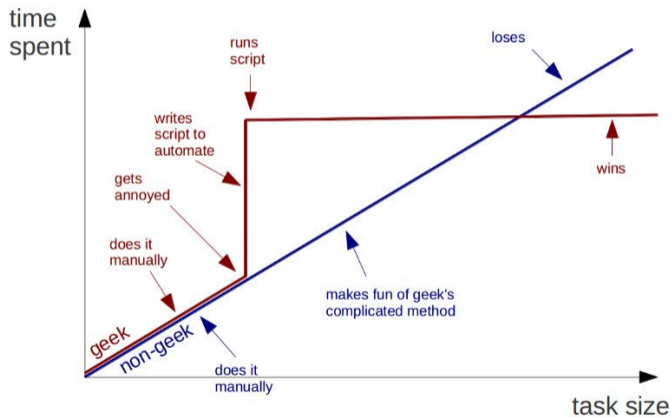
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- Core Principle: **Ruthless Automation.**
- Doing something boring and repetitive? especially for the second or third time?
- You are a **programmer**, so think to yourself: **Can I save time by automating this?**

Or, to put that another way (as seen on the walkway a couple of years ago):

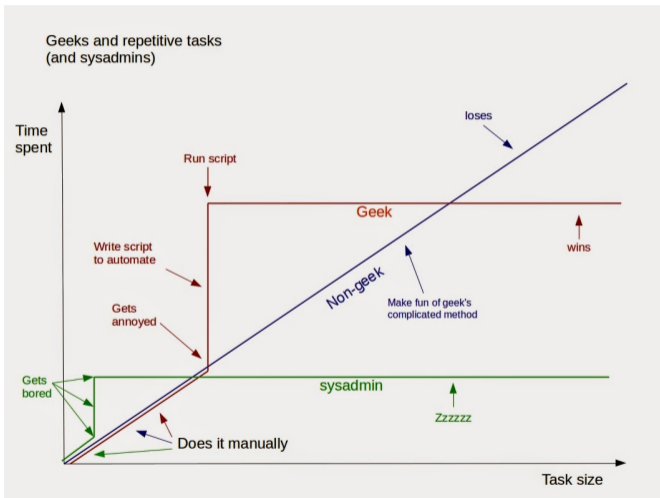


Or, to put that another way (thanks due to SwissMiss):

## Geeks and repetitive tasks



Or, adding SysAdmins into the mix:



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- **Programmer's Editors:** Use a single editor well.
- **Automating Compilation:** Use make.
- **Multi-Directory Programs and Libraries:** How to lay out programs in multiple directories, a Makefile per directory.
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- There's a tarball of examples associated with each lecture, as a shorthand [tarball 01.intlist](#) refers to the directory called **01.intlist** inside the tarball. Each directory contains a README file.

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- Why? Because programmers are notoriously sectarian when it comes to..



# EDITOR WARS

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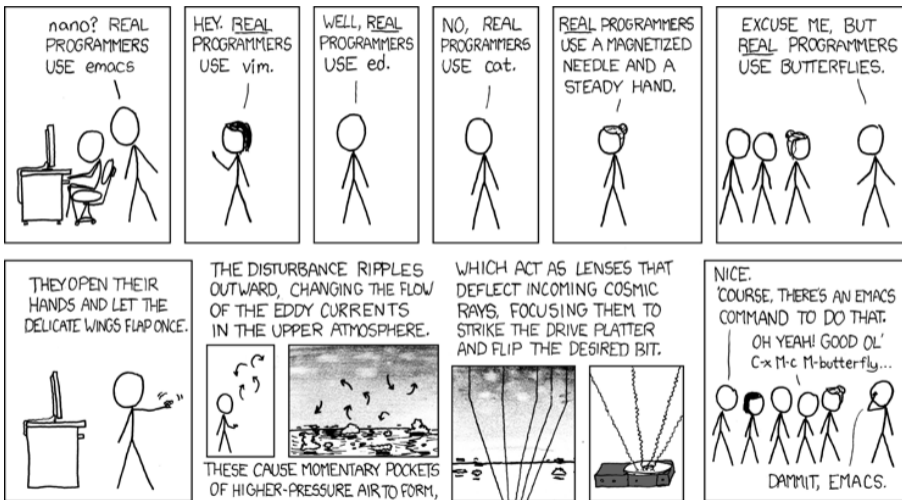
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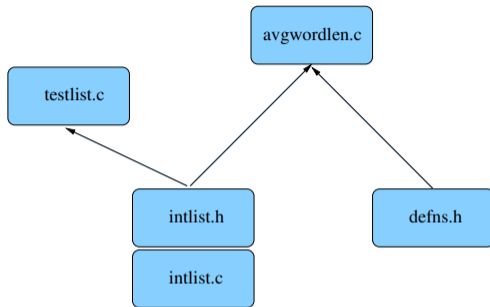


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- Note that [Hunt & Thomas](#) aren't much in favour of IDEs. Neither am I:-)

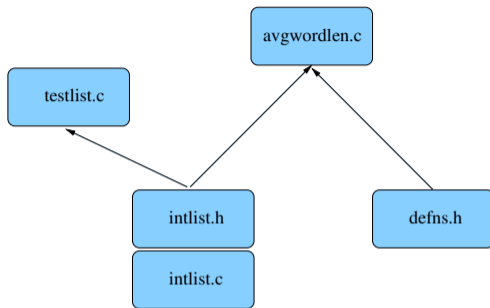
Actually, it's well known that **Real Programmers** use **Butterflies** to edit source code:



When multi-file C programming, there are **many source files**, eg:

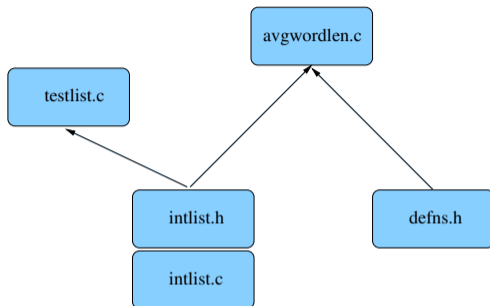


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- Module **intlist** comprising two files (interface **intlist.h** and implementation **intlist.c**) - defining a list-of-integers type.
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So, what should we compile? what should we link?



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intlist.c:#include "intlist.h"  
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- **Make** uses such file dependencies, encoded in a **Makefile**, to automatically compile your programs.
- The Makefile contains dependency rules between **target** and **source** files with **optional actions** (commands) to generate each target from the corresponding sources.

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- Note that Make needs very few explicit dependencies and even fewer explicit actions, because it already knows that `intlist.o` depends on `intlist.c`, and how to compile `.c` files.

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- `make` takes optional target names on the command line (defaulting to the first target), then performs the **minimum number of actions** needed to bring the desired targets **up to date**, based on the **timestamps** of the target and source files.
- For example, if `intlist.h` is altered, you run `make`, that builds the target `all`, which recursively applies all the rules checking timestamps and concludes that...
- ...`intlist.c`, `testlist.c` and `avgwordlen.c` need recompiling, and then the new `testlist.o` and `avgwordlen.o` need relinking against the new `intlist.o`, giving the 2 executables `testlist` and `avgwordlen`.

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- Summary: *Always use `make`*, or some similar tool. Keep your Makefile dependencies up to date, optionally auto-generating your Makefiles.
- Google [make tutorial](#) for more info.

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- What to split? The intlist module is:
  - Logically separate.
  - Reusable - whenever we want a list of integers.
  - Depends on only the standard library.
- That is, it's **highly cohesive**.
- So: it's perfect for splitting out into a library sub-directory.
- In tarball directory **04.intlist-with-lib**, you'll see what we have done to achieve this.

- There's a separate `lib` sub-directory, let's explore it first:
- `lib` contains `intlist.c`, `intlist.h`, `testlist.c` and it's own Makefile, `lib/Makefile`, which builds two core targets:
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- To do this, `lib/Makefile` has the following new parts:

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LIBOBJS  =      intlist.o
BUILD    =      testlist $(LIB)

...
$(LIB):      $(LIBOBJS)
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- The new rule says that `$(LIB)` depends on `$(LIBOBJS)`, i.e. `libintlist.a` depends on `intlist.o`, and that the action invokes `ar` and `ranlib` - tools that build library files.

- The top-level directory contains `avgwordlen.c` and `defns.h`, and a Makefile, containing the following new parts:

```
CFLAGS    =      -Wall -Ilib
LDLIBS    =      -Llib -lintlist
BUILD     =      libs avgwordlen
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- In LDLIBS, `-Llib` tells the linker to search for libraries in the lib directory, and `-lintlist` links the intlist library in.

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BUILD    =      libs avgwordlen
```

- In `CFLAGS`, `-Ilib` tells the C compiler to search for include files in the `lib` directory.
- In `LDLIBS`, `-Llib` tells the linker to search for libraries in the `lib` directory, and `-lintlist` links the `intlist` library in.
- In `BUILD`, I've added `libs` before `avgwordlen`. Later down the main Makefile, we see a rule to make `libs`:

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libs:
    cd lib; make
```

- The top-level directory contains `avgwordlen.c` and `defns.h`, and a Makefile, containing the following new parts:

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- This new `always run` rule tricks Make, with it's single directory view of the world, into first building in the `lib` sub-directory, before building in the current directory.

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- Left for you to work through!

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- Go through that, and you'll get a taste of how CMake lists files are constructed. But CMake is over complex for my tastes. Also, any tool that needs to be run in it's own build subdirectory in order to leave the source code directory uncluttered is too messy for me!